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**Wang et al.**

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(54) **LIQUID CRYSTAL DISPLAY, DRIVER CHIP AND DRIVING METHOD THEREOF**

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**G06F 3/38** (2006.01)  
**G09G 3/36** (2006.01)

(52) **U.S. Cl.** ..... **345/98**; 345/87; 345/90; 345/99; 345/100; 345/204

(58) **Field of Classification Search** ..... 345/90, 345/98-100, 87, 204

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,657,622	B2 *	12/2003	Park	345/205
7,061,478	B1 *	6/2006	Moyer	345/204
7,260,494	B2	8/2007	Weiss	702/120
7,289,095	B2	10/2007	Park et al.	345/98
2001/0013850	A1	8/2001	Sakaguchi et al.	345/87
2003/0038771	A1 *	2/2003	Sunohara	345/103
2004/0075636	A1	4/2004	Pai	345/103
2005/0052395	A1 *	3/2005	Choi et al.	345/98
2005/0068309	A1 *	3/2005	Chang et al.	345/204
2005/0083289	A1	4/2005	Yang	345/100
2005/0219189	A1	10/2005	Fukuo	
2005/0219235	A1	10/2005	Fukuo	

FOREIGN PATENT DOCUMENTS

JP	11-212672	8/1999
JP	11-242463	9/1999
JP	2005-338727	12/2005
TW	0567459	12/2003
TW	567459	12/2003

\* cited by examiner

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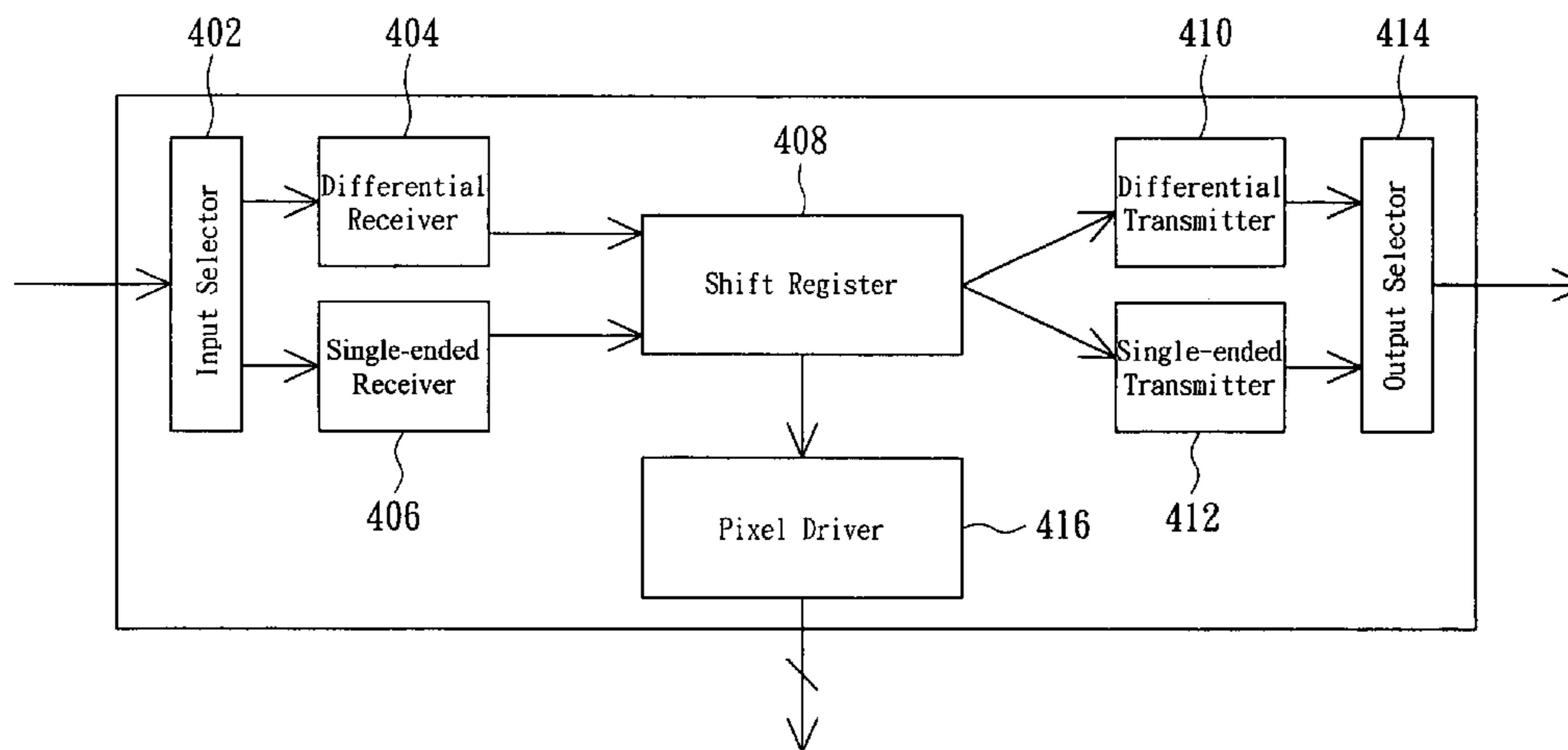
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(57) **ABSTRACT**

A liquid crystal display and the driving method thereof. The LCD includes a timing controller, a plurality of driver chips and a display panel. The driver chips are cascaded together for driving the display panel to display frames. A driver chip includes a differential receiver, a single-ended receiver, a shift register, a differential transmitter, a single-ended transmitter and a pixel driver. The driver chip receives a pixel signal and drives the display panel according to the pixel signal, and outputs the pixel signal to the next driver chip.

**26 Claims, 4 Drawing Sheets**

304



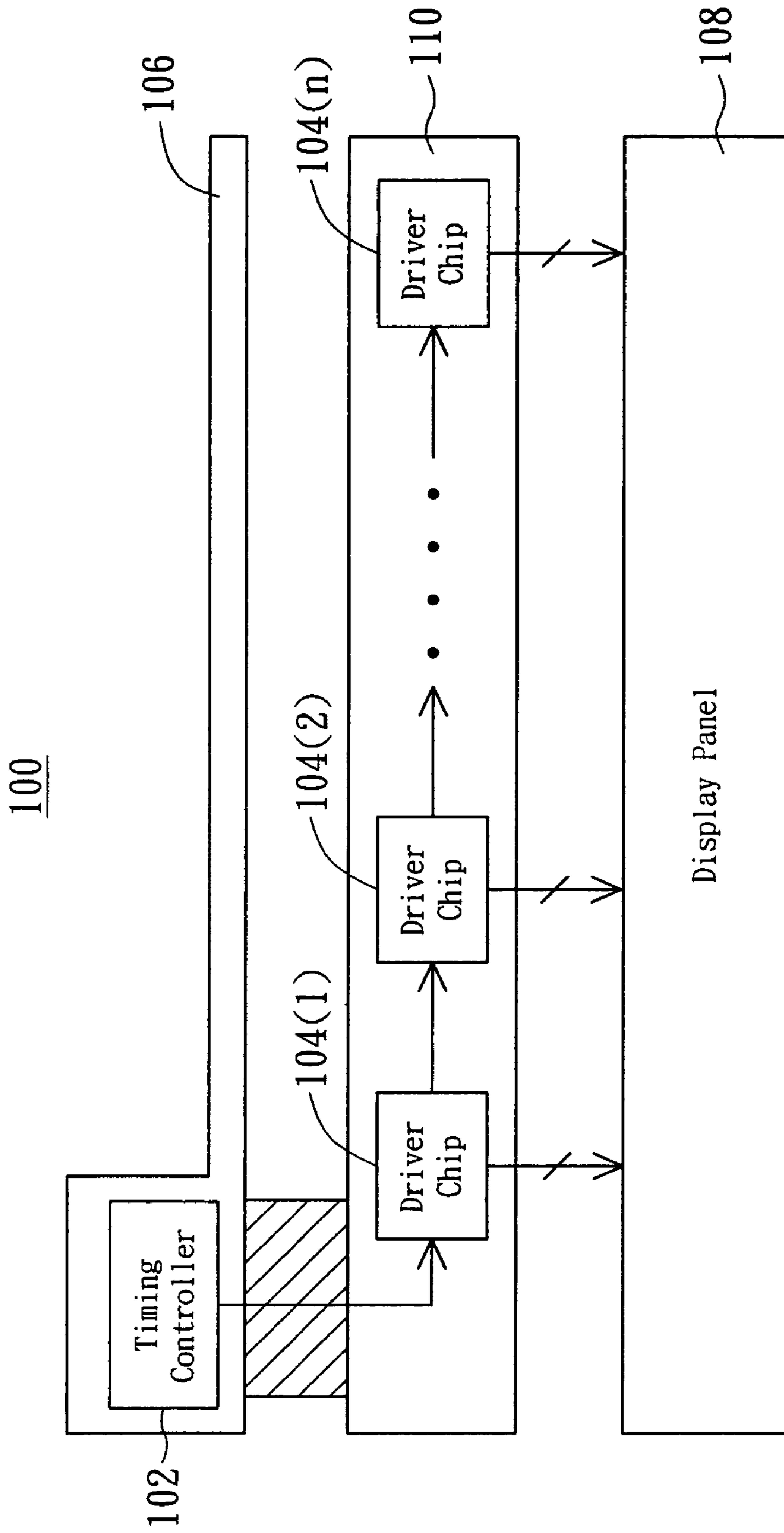


FIG. 1 (PRIOR ART)

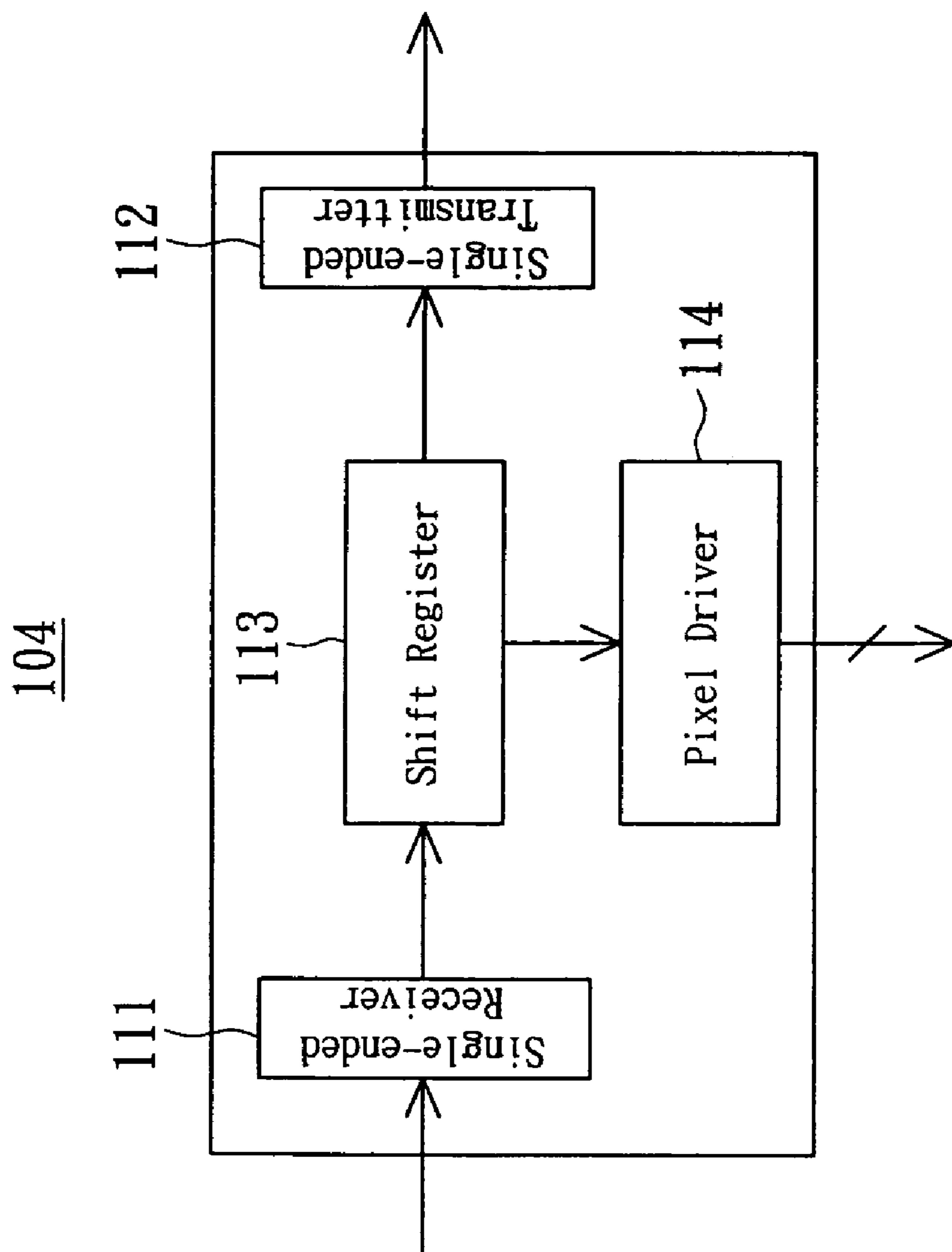


FIG. 2(PRIOR ART)

300

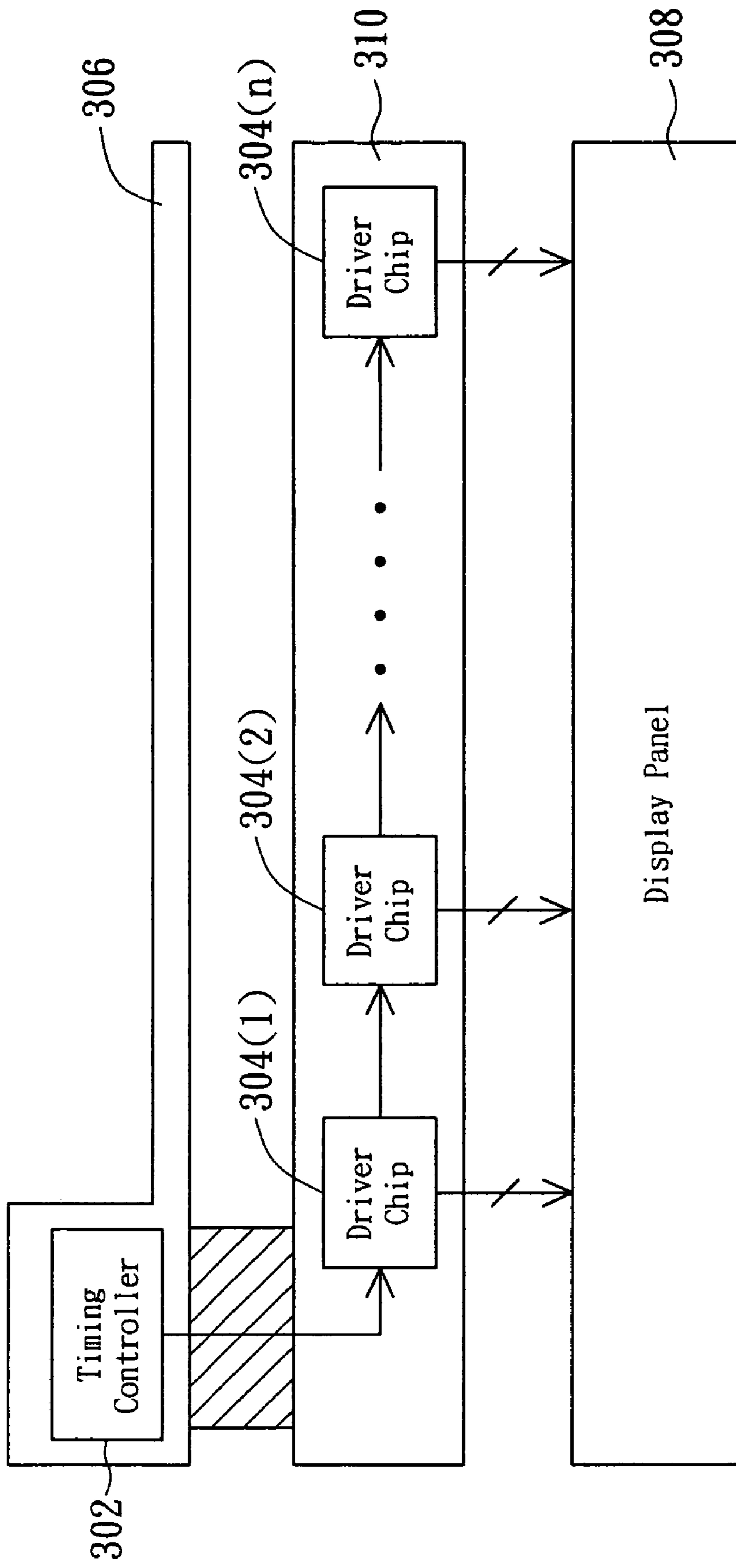


FIG. 3

304

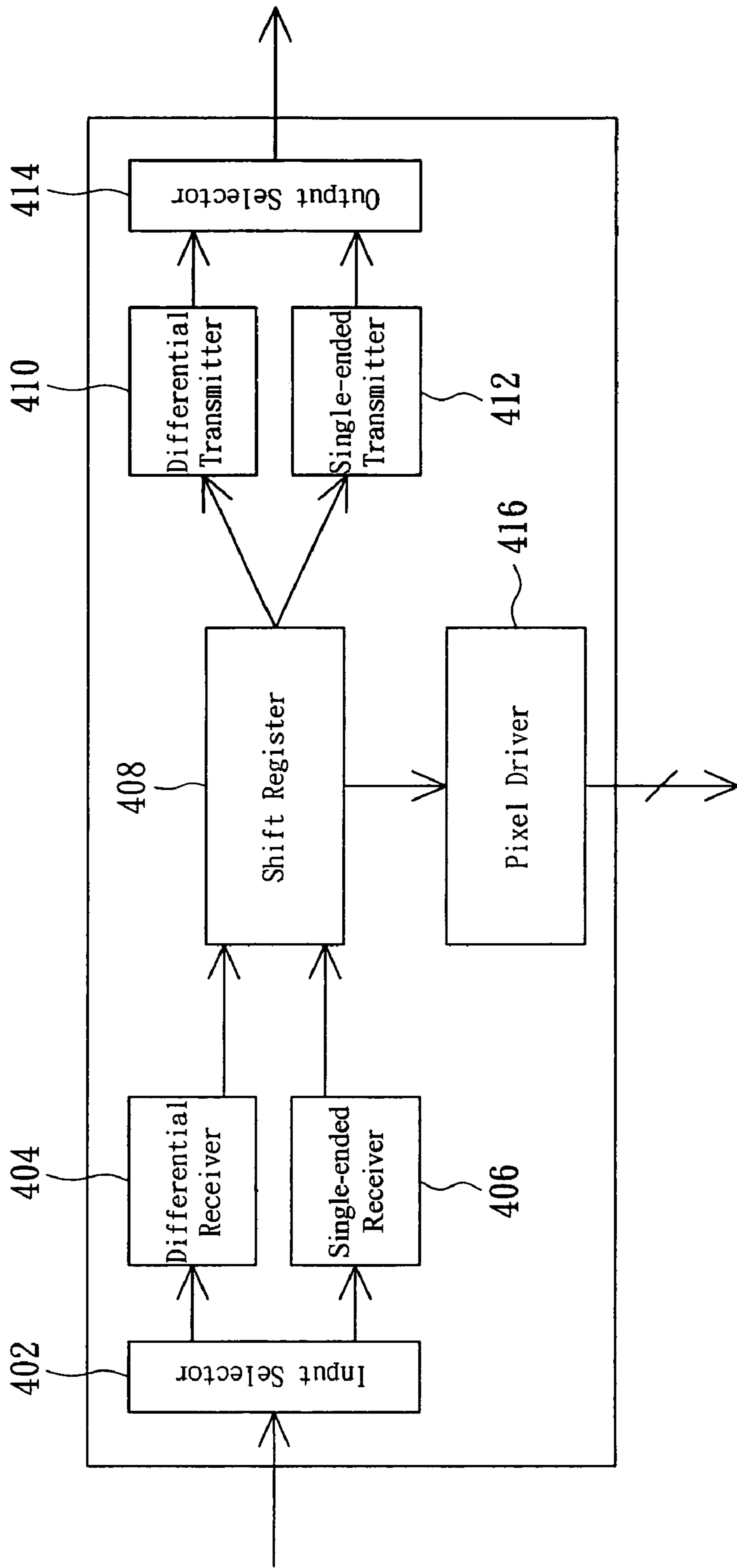


FIG. 4

## LIQUID CRYSTAL DISPLAY, DRIVER CHIP AND DRIVING METHOD THEREOF

This application is a continuation application of co-pending application Ser. No. 12/232,438, filed on Sep. 17, 2008, which is a continuation application of application Ser. No. 11/034,858, filed on Jan. 14, 2005, now U.S. Pat. No. 7,483,006, and claims the benefit of Taiwan application Serial No. 93121223, filed Jul. 15, 2004, the subject matter of which is incorporated herein by reference.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The invention relates in general to liquid crystal displays, and more particularly to liquid crystal displays and the driver chips of the liquid crystal displays having dual transmitting modes.

#### 2. Description of the Related Art

FIG. 1 shows a conventional liquid crystal display (LCD). LCD 100 includes timing controller 102, n driver chips 104 that are cascaded together, display panel 108, PCB (print circuit board) 106, and glass substrate 110. The timing circuit 102 on PCB 106 is used for outputting pixel signals that are in single-ended type. The first driver chip 104(1) is electrically connected to the timing controller 102. Driver chips 104(1), 104(2), 104(3) . . . 104(n) are cascaded together. After driver chip 104(1) receives the pixel signal from the timing controller 102, the pixel signal is sent to driver chip 104(2); driver chip 104(2) then in turn sends this pixel signal to the next driver chip 104(3), and continues in this fashion until the pixel signal is being sent to the last driver chip 104(n). Each driver chip 104 drives panel 108 according to the captured pixel signal. Each driver chip 104 is disposed on the glass substrate 110, and such layout on the glass substrate is referred to as chip on glass (COG).

FIG. 2 shows a conventional driver chip. Between the driver chip 104, the pixel signals are being transmitted in single-ended type. Driver chip 104 includes single-ended receiver 111, single-ended transmitter 112, shift register 113, and pixel driver 114. Single-ended receiver 111 and single-ended transmitter 112 are for example CMOS TTL circuits. Single-ended receiver 111 first receives pixel data, then sends the pixel data to shifter register 113, then shift register 113 in turn sends the pixel data to single-ended transmitter 112 for outputting to next driver chip. Pixel driver 114 retrieves data corresponding to the driver chip from shift register 113 of the chip, and uses the retrieved data to drive the display panel 108.

However, due to the large impedances of glass substrate conducting wires, the pixel signals are severely attenuated when being transmitted through the glass substrate conducting wires disposed between the driver chips. Especially for high resolution LCDs, the number of driver chips required are even greater, and the signal attenuation problem becomes more severe, since the signals have to travel a greater distance, and the application of this type of layout in high resolution LCDs remains a difficult issue.

### SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a liquid crystal display and the driver chip thereof that prevents pixel signals from attenuating during transmitting, and increases the transmitting clock rate.

The invention achieves the above-identified object by providing a liquid crystal display (LCD), which includes a timing

controller, a cascaded plurality of driver chips, and a display panel. The timing controller outputs pixel signals to the first driver chip of the driver chips, in which the driver chip receives the pixel signal according to a preset receiving mode, and outputs the pixel signal to the second driver according to a preset output mode, and the pixel signal continues to be transmitted in the same fashion until reaching the last driver chip. Each of the driver chips samples the pixel signals and uses the sampled pixel signals to drive the display panel.

The invention achieves the other above-identified object by providing a method of transmitting data in a LCD. The LCD includes a timing controller, and a first driver chip and a second driver chip that are cascaded together. The method of transmitting data in the LCD includes the following steps. First, a pixel signal is output from the timing controller. Then, the first driver chip receives the pixel signal according to the preset receiving mode, and retrieves the pixel signal. Then, the first driver chip sends the pixel signal to the second driver chip according to the preset output method.

Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 (PRIOR ART) shows illustration of a conventional liquid crystal display.

FIG. 2 shows illustration of a conventional driver chip.

FIG. 3 shows illustration of a driver circuit of a liquid crystal display according to a better embodiment of the invention.

FIG. 4 shows illustration of a driver chip according to a better embodiment of the invention.

### DETAILED DESCRIPTION OF THE INVENTION

FIG. 3 shows illustration of a driver circuit of a LCD according to a preferred embodiment of the invention. LCD 300 includes a timing controller 302, n driver chips 304 that are cascaded together, a Print Circuit Board (PCB) 306, and a glass substrate 310. Timing controller 302 disposed on PCB 306 outputs a pixel signal, such as in a differential type. First driver chip 304(1) is electrically connected to timing controller 302. Driver chip 304(1), 304(2), 304(3) . . . 304(n) are serially connected. Driver chip 304(1) disposed on glass substrate 310 receives the pixel signal output from timing controller 302, and then sends the pixel signal to next driver chip 304(2), and driver chip 304(2) in turn sends the pixel signal to next driver chip 304(3), and the pixel data continues to be transmitted in this fashion until reaching the last driver chip 304(n). The pixel signal is being transmitted between the driver chip 304 in differential mode, or in alternation between differential mode and single-ended mode. Each driver chip 304 uses the retrieved pixel signals to drive display panel 308. Glass substrate 310 is the base of driver chip 304, and such method of transmitting data through driver chips that are cascaded together, or in an array, is referred to as WOA (Wire on Array).

FIG. 4 shows illustration of a driver chip according to the preferred embodiment of the invention. Each driver 304 includes input selector 402, differential receiver 404, single-ended receiver 406, shift register 408, differential transmitter 410, single-ended transmitter 414, output selector 414, and pixel driver 416.

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Driver chip 304 has a preset receiving mode and a preset output mode, wherein the preset receiving mode can be a differential mode or a single-ended mode, and the preset output mode also can be a differential mode or a single-ended mode. Driver chip 304 receives the pixel signal according to the preset receiving mode of the driver chip 304, and output the pixel signal according to the preset output mode of the driver chip 304. Input selector 402 is for outputting the pixel signal after receiving the pixel signal: when input selector 402 preset receiving mode is the differential mode, the differential receiver 404 is enabled by input selector 402 to receive the pixel signal, and convert the pixel signal into an internal signal before outputting, and the internal signal in this embodiment is converted into single-ended type; when the preset receiving mode is the single-ended mode, the single-ended receiver 406 is enabled by input selector 402 to receive the pixel signal, and convert the pixel signal into an internal signal before outputting, the internal signal in this embodiment remains in single-ended type.

Shift register 408 is for receiving and temporarily storing the internal signal from differential receiver 404 or single-ended receiver 406. Differential transmitter 410 is for receiving and converting the internal signal output by shifter register 408, and outputting the pixel signal in differential type; single-ended transmitter 412 is for receiving and converting the internal signal output by shift register 408, and outputting the pixel signal in single-ended type.

Output selector 414 selectively outputs the pixel signal output by differential transmitter 410 or single-ended transmitter 412 according to the preset output mode. When preset output mode is the differential mode, output selector 414 outputs the pixel signal output by differential transmitter 410; when the preset differential mode is the single-ended mode, the output selector 414 outputs the pixel signal output by single-ended transmitter 412. Pixel driver 416 retrieves data corresponding to the driver chip from shift register 408, and drives display panel 308 to display image according to the data.

While the LCD disclosed by the above described embodiment of the invention was demonstrated with driver chips having differential and single-ended receive and output modes, the driver chip can also be only having a differential input and output modes, which will not be further discussed here.

Although the LCD according to the embodiment of the invention transmits data by way of WOA, the pixel signals can be transmitted in differential mode between driver chips in order to prevent pixel signals from being severely attenuated, or can be transmitted alternatively in differential and single-ended mode between the driver chips in order to incorporate both the low power consumption advantage of single-ended signals, and the good signal quality advantage of differential signals. Also, by using differential mode in signal transmitting, high resolution can be easily attained when applying in high resolution LCDs.

While the invention has been described by way of example and in terms of a preferred embodiment, it is to be understood that the invention is not limited thereto. Rather, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A method for transmitting data in a first driver chip on a liquid crystal display (LCD), comprising:

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- providing a first pixel signal, wherein the first pixel signal has a first signal-type and a second signal-type, and the second signal-type is different from the first signal-type; receiving the first pixel signal either in the first signal-type or in the second signal-type;
- transmitting a second pixel signal according to the first pixel signal, wherein the second pixel signal has a first signal-type and a second signal-type; and outputting the second pixel signal either in the first signal-type or in the second signal-type.
2. The method according to claim 1, further comprising: converting the first pixel signal into the second pixel signal.
3. The method according to claim 2, wherein the LCD has a timing controller for providing the first pixel signal.
4. The method according to claim 3, wherein the second pixel signal outputs to a display panel of the LCD.
5. The method according to claim 3, wherein the second pixel signal outputs to a second driver chip of the LCD.
6. The method according to claim 5, wherein the first signal-type is a differential type and the second signal-type is a single-ended type.
7. The method according to claim 6, further comprising: the second driver chip outputting a third pixel signal, wherein the third pixel signal has a first signal-type and a second signal-type.
8. The method according to claim 6, further comprising: the second driver chip outputting a third pixel signal in a first signal-type.
9. The method according to claim 6, further comprising: the second driver chip outputting a third pixel signal in a second signal-type.
10. A method for transmitting data in a first driver chip on a liquid crystal display (LCD), comprising: providing a first pixel signal, wherein the first pixel signal has a first signal-type and a second signal-type, and the second signal-type is different from the first signal-type; receiving the first pixel signal either in the first signal-type or in the second signal-type; and transmitting a second pixel signal according to the first pixel signal, wherein the second pixel signal has a first signal-type.
11. The method according to claim 10, further comprising: converting the first pixel signal into the second pixel signal.
12. The method according to claim 11, wherein the LCD has a timing controller for providing the first pixel signal.
13. The method according to claim 12, wherein the second pixel signal outputs to a display panel of the LCD.
14. The method according to claim 12, wherein the second pixel signal outputs to a second driver chip of the LCD.
15. The method according to claim 14, wherein the first signal-type is a differential type and the second signal-type is a single-ended type.
16. The method according to claim 15, further comprising: the second driver chip outputting a third pixel signal, wherein the third pixel signal has a first signal-type.
17. The method according to claim 14, wherein the first signal-type is a single-ended type and the second signal-type is a differential type.
18. The method according to claim 17, further comprising: the second driver chip outputting a third pixel signal, wherein the third pixel signal has a first signal-type.
19. A method for transmitting data in a first driver chip on a liquid crystal display (LCD), comprising: providing a first pixel signal, wherein the first pixel signal has a first signal-type and a second signal-type, and the second signal-type is different from the first signal-type; determining a receiving mode of the first pixel signal;

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receiving and converting the first pixel signal according to the receiving mode of the first pixel signal into a first internal signal and temporarily storing the first internal signal in the first driver chip, wherein when the first pixel signal has the first signal-type, the first internal signal converted from the first pixel signal has the first signal-type and the second signal-type; and

converting the first internal signal into a second pixel signal and outputting the second pixel signal according to an output mode of the second pixel signal.

**20.** The method according to claim **19**, wherein when the receiving mode of the first pixel signal has the first signal-type, the second pixel signal has the second signal-type.

**21.** The method according to claim **20**, wherein when the receiving mode of the first pixel signal has the second signal-type, the second pixel signal has the second signal-type.

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**22.** The method according to claim **21**, wherein the first signal-type is a differential type and the second signal-type is a single-ended type.

**23.** The method according to claim **21**, wherein the first signal-type is a single-ended type and the second signal-type is a differential type.

**24.** The method according to claim **19**, wherein when the receiving mode of the first pixel signal has the first signal-type, the second pixel signal has the first signal-type.

**25.** The method according to claim **24**, wherein the first signal-type is a differential type and the second signal-type is a single-ended type.

**26.** The method according to claim **24**, wherein the first signal-type is a single-ended type and the second signal-type is a differential type.

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